Health Insurance, Treatment and Outcomes:

Using Auto Accidents as Health Shocks*

Joseph J. Doyle, Jr.

MIT Sloan School of Management

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Abstract:

Previous studies find that the uninsured receive less health care than the insured, yet differences in health outcomes have rarely been studied. In addition, selection bias may partly explain the difference in care received. This paper focuses on an unexpected health shock—severe automobile accidents where victims have little choice but to visit a hospital. Another innovation is the use of a comparison group that is similar to the uninsured: those who have private health insurance but do not have automobile insurance. The medically uninsured are found to receive twenty percent less care and have a substantially higher mortality rate.

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1. Introduction

Efforts to reform the $1.3 trillion U.S. healthcare industry are often motivated by a concern that the uninsured are denied access to health care (NCHS, 2002). Indeed, the uninsured are less likely to pay for care, and theory suggests that they would receive less treatment. Previous empirical work supports this conclusion and finds that the uninsured receive approximately forty percent less health care than the insured.

While treatment differences have been labeled the 'access gap', they can be difficult to interpret. First, health outcomes are rarely compared. Without knowing the effect on health, treatment differences may imply that the insured receive too much care, rather than the uninsured receiving too little. For example, moral hazard problems may allow physicians to practice 'flat-of-the-curve medicine', where diminishing returns to medical care imply small health gains with additional treatment (Enthoven, 1980). While the insured may receive more care, this may not translate into health differences.

Further, there may be selection problems. Individuals decide to purchase insurance and they decide to seek medical care. If those with a low risk of using medical care are also less likely to purchase insurance, then treatment differences may have little to do with access to care. This positive correlation between risk level and insurance coverage is a standard result in contract theory and suggests that information problems in insurance markets may lead to treatment differences. The measurement of these differences is further complicated by the lack of an adequate comparison group to test whether unobserved differences between the insured and uninsured drive the difference in care received.

To examine health outcomes and consider selection problems, this paper focuses on an unexpected health shock—severe automobile accidents where incapacitated crash victims have little choice but to use professional medical care. Using a unique data set that links police accident reports to hospital discharge records, treatment levels and mortality rates are compared between the insured and uninsured. These data provide a complete picture of each accident and offer a new way to investigate whether the uninsured are denied access to life-saving health care. One innovation in the paper is the use of a comparison group that is similar to the uninsured in terms of observed risk-taking behavior, income, vehicle, and injury characteristics: drivers who have health insurance but do not have *automobile* insurance.

The focus on severe automobile accidents has four main advantages. First, police record mortality, which allows a comparison of health outcomes. Second, contact with professional health care providers is virtually automatic for severe accidents, as ambulances arrive as part of the crash investigation. It is then possible to compare patients who were injured in a similar way and immediately sent to the hospital.

Third, severe accidents are largely unexpected at the time of the health insurance purchase decision, as opposed to the chronic conditions that are usually studied (Brown, 1998). Patients live with chronic health problems and gain private information about future health care use. These are cases where adverse selection problems are at their most extreme, as those likely to use health care may be more likely to purchase insurance. In contrast, if the decision to purchase insurance were not based on the likelihood of being in a severe automobile accident, then the approach taken here would largely avoid this selection problem.

Finally, automobile accidents are a particularly important health problem for the uninsured. Most health problems are common to older individuals who are almost universally insured. In contrast, the uninsured tend to be younger, and automobile accidents are the leading cause of death among those under the age of thirty-five (CDC, 1998).

The results suggest that the uninsured receive twenty percent less treatment than the privately insured, controlling for personal, crash, vehicle, neighborhood, and hospital characteristics. The uninsured are also found to have a substantially higher mortality rate—an increase of 1.5 percentage points compared to the mean mortality rate of 3.8%.

The structure of the paper is as follows. Section two briefly presents theoretical considerations and a review of previous work to guide the interpretation of the results and place them in context. Section three describes the data and presents mean comparisons of treatment, mortality, and crash characteristics between the insured and uninsured. Section four presents the empirical estimates where within-hospital variation is used to test the effect of insurance status on treatment and mortality. Section five discusses a number of specification and robustness tests, including an examination of differences in procedures performed. These tests suggest that the ability-to-pay of patients, and not unobserved health differences, are driving the differences in treatment and mortality. Section six considers the implications of the findings, and section seven concludes.

2. Background

At the time of an accident, insurance lowers the price of health care faced by the insured and raises the effective price that providers collect. Both factors suggest that the insured will receive more treatment. The overall effect of insurance on treatment decisions, and ultimately health outcomes, is a combination of these supply and demand factors.[1] This paper considers serious crashes where the decision to visit the hospital is largely out of the control of the patient, as police or witnesses call for medical professionals. Once in the hospital, the uninsured (and family members) may help decide on treatment, but for the most complicated decisions, such as emergency brain surgery or spinal fusion, the decisions would likely be made on the supply side.

The effect of reimbursement rules on treatment decisions has received considerable attention, begun by McGuire and Ellis (1986). In these models, physicians choose treatment levels to maximize an objective function that includes both profits and the benefits of treatment to patients. The model suggests that an increased ability-to-pay, through insurance for example, would result in greater treatment. This is partially due to moral hazard problems, though it does not depend on profits being part of the objective function. If profits were incorporated into a resource constraint, where insured patients subsidize the uninsured, then the prediction of more treatment for the insured would remain.

Another factor affecting the supply response is whether insurance status is in the provider's information set at the time treatment decisions are made. In fact, it appears that one of the first pieces of information discovered is insurance status. Medical professionals search patients to find not only insurance information, but medical and emergency contact information as well. Insurance companies regularly recommend that consumers carry their insurance card especially for this type of situation. Once known, the expected payer is reported on the patient's chart. When treatment decisions are made, insurance status is likely known.

Finally, treatment differences may be smaller given the legal ramifications of refusing to treat patients. For example, federal law mandates that hospitals stabilize trauma patients. While hospitals have an incentive to transfer patients that are a higher financial risk, little evidence of such transfers is found following severe crashes, as discussed below. Regardless, treatment differences are predicted, as long as physicians have some discretion over treatment levels.

Previous Literature

Many previous studies find that the uninsured receive less care than the insured, but few studies consider the effect on health.[2] The most extensive study was the Rand Health Insurance Experiment, where over two-thousand families were randomized to health plans that varied by co-payment levels (Newhouse, 1993). The study found few effects of free coverage on health, though a slight improvement in blood pressure was found.

Similar to the study of automobile accidents, Currie and Gruber (1997) consider a case where the use of a hospital is less of a choice: childbirth. Using exogenous variation in Medicaid expansions, lower educated women were found to receive more treatment with greater access to insurance. Only minor effects on neonatal mortality were found, unless the mother lived near a hospital with a Neonatal Intensive Care Unit (NICU). For these mothers, the expansions had a large effect on neonatal mortality. The 24% increase in eligibility from 1987-1992 was estimated to result in an 11% decrease in mortality. This interaction with NICUs suggests that insurance does have an effect on the most costly, potentially life-saving care. It appears, then, that the hospitals chosen by the uninsured may also affect treatment differences. In a related paper, Currie and Gruber (1996) find that the 15.1% increase in eligibility for all groups over the period 1984-1992 was associated with an 8% decrease in child mortality.

A few studies in the health literature also consider outcome differences and find mixed evidence of insurance effects. For example, Ayanian et al. (1993) study breast cancer patients in New Jersey and find that the uninsured are more likely to suffer from serious conditions, and have a 49% higher mortality rate. Sada et al. (1998) considered heart attack patients and find that the uninsured were half as likely to receive angiography, but find no difference in mortality. Haas and Goldman (1994) consider trauma patients in Massachusetts and find that the uninsured are 32% less likely to receive surgery and are twice as likely to die.

Some of the problems with these earlier studies can be dealt with by the focus on automobile accidents, and the use of linked police and hospital data. First, this paper uses within-hospital variation to explicitly control for hospital resources and incentives. Second, previous papers naturally relied upon physician diagnoses and procedures to categorize patients by injury severity.[3] These categories are likely endogenous, however, as diagnoses and procedures are likely affected by insurance status if the uninsured receive less care. One advantage of the linked police data is that police measures of accident severity are less likely to be influenced by the victim's health insurance status. Instead, patients who were involved in similar crashes are compared in an effort to control for injury severity. For example, a patient who crashed on a rural highway resulting in severe vehicle damage will have greater injuries compared to a patient who crashed on a slower moving urban street.

Further, the choice of when to visit the hospital, even for cases such as heart attacks, can be associated with insurance status and affect the interpretation of the results. This paper instead focuses on a case where the decision of when to visit the hospital is not made by the patient, and offers a new way to investigate the effect of insurance status on treatment and health.

3. Data Description

The Crash Outcome Data Evaluation System (CODES) offers a unique data set to compare patients following an automobile accident. CODES links police accident reports with hospital discharge records using identifiers such as patient name, birth date, and time of accident. The National Highway Traffic Safety Administration subsidized individual state efforts to link these two sources of data, and, until now, they have only been used to study highway safety (NCSA, 1998).

This paper uses data from Wisconsin for the period 1992 through 1997.[4] In Wisconsin, all police accident reports are submitted to the Wisconsin Department of Transportation, and all inpatient hospital records are submitted to the Wisconsin Department of Health and Family Services. Analysts at the Center for Health Systems Research and Analysis (CHSRA), located at the University of Wisconsin at Madison, linked the data and calculated that 80% of all crash-related hospitalizations were linked successfully. Reasons for linkage failure include the following: the crash victim died at the scene, the patient was transported out of Wisconsin, the crash record contained insufficient identifying information, or the crash was not reported to the police. For the severe accidents investigated here, police reports are more likely. While it is not possible to compare linkage rates by insurance status—such status is only known for linked cases—CHSRA data documentation argues that "there is no reason to expect that the cases not linking are different from cases which do link." For the same reason, mortality rates at the scene of the accident cannot be compared across insurance groups, so all mortality comparisons are analyzed for crash victims who arrived at a hospital.

Police Measures

The police-report data offer a complete picture of each accident. Characteristics such as age, sex, seat location, seat belt use, entrapment in the vehicle, and injury severity are available. Wisconsin Police report injury severity according to the KABCO score: Killed; A, B, or C injuries consisting of incapacitating injuries, non-incapacitating injuries, or possible injuries; and other or unknown. At the accident scene, a police officer records the injury category. If the crash victim later died due to the accident, then the injury severity was scored as a K—even if the death occurred after hospital discharge.[5] Total hospital facility charges increase with police-measured injury severity, suggesting that the evaluations are informative. The linked police data also provide a novel comparison group: drivers who have health insurance but do not have automobile insurance. This information is recorded because it is illegal to drive in Wisconsin without having such insurance. Other crash characteristics include vehicle damage, the time of the accident, alcohol involvement, road condition, population size where the accident occurred, and the types of crashes, vehicles, and roads.

The police also record the Vehicle Identification Number (VIN) for crash victims in cars and trucks. These VINs were decoded by Primedia Price Digests to categorize vehicles by engine size, manufacturer's suggested retail price, two-door status, vehicle weight, and model year. These measures are used to control for automobile quality, which can affect injury severity and serve as a proxy for socio-economic status.

The ZIP code of residence is also included in the report. This information allows a comparison of neighborhood characteristics such as the fraction of the population in poverty, race categories, educational categories, and median household income, available from the 1990 US Census. Patients from wealthier backgrounds may receive favorable treatment and are more likely to have insurance. Controls for neighborhood characteristics provide a way to isolate the effect of insurance on treatment and health outcomes.

Hospital Measures

The hospital discharge data also provide a rich set of variables. These include age, sex, and ZIP code of residence, in addition to measures of treatment, such as total facility charges, length of stay, up to three procedure codes, and up to five diagnosis codes. The total facility charges represent the standard room and procedure charges as opposed to the amount billed to insurance companies or the government. This is particularly useful for research purposes, as charges are uniform across insurance plans within each hospital. Facility charges also approximate the cost of care. Audits performed by Medicaid and Medicare suggest that the cost of the treatment is roughly seventy percent of charges, but items that are excluded from facility charges, such as physician fees, roughly offset this adjustment.[6] Major diagnostic categories are also used to compare patients with similar types of injuries, such as nervous system or musculoskeletal.

Finally, the expected payer is reported. As in previous work, "uninsured" is defined as having the expected payer identified as self-pay as opposed to a form of private insurance or government program. While the uninsured may be partially insured through subsequent lawsuits or through automobile insurance, these are uncertain payments that hospitals do not look to first. For example, the hospital would have to judge the probability that another driver caused the accident times the probability that the other driver has liability insurance, in which case the hospital may receive payment much later.[7] In addition, medical coverage within automobile insurance contracts is optional and usually capped at a low payment level, such as $2500—far below the costs of care in these severe crashes. Meanwhile, the patient's chart will note the lack of insurance as opposed to any partial coverage afforded to crash victims. It appears, then, that hospitals would regard the uninsured as likely candidates for uncompensated care, while the partial coverage will make finding treatment differences for the uninsured more difficult.

The total number of linked police-hospital records is 28,236 and ten percent are uninsured, similar to the 9-11% rate of uninsurance in Wisconsin at this time (Kaiser Family Foundation, 1998). The sample is restricted in a number of ways to provide more meaningful estimates of treatment and mortality differences, though results are similar when the entire data set is used as discussed below. First, to consider patients who are the least likely to make treatment decisions, the estimation focuses on the most severely injured patients: those who were judged by the police to be incapacitated and those who eventually died.[8] This results in 16,648 observations. Patients over the age of sixty-five are excluded due to near universal insurance coverage through Medicare. Also, hospital records are available for patients where they were finally discharged, so patients who transferred from another hospital will mechanically have shorter lengths of stay. These observations are dropped for comparability, though it does not appear that hospitals transfer the financial risk of treating uninsured patients to other hospitals.[9] Finally, comparisons are first restricted to the uninsured and the privately insured. Comparisons with Medicaid recipients are made separately. These restrictions result in 10,842 patients to study, of which nearly fifteen percent are uninsured.[10]

Differences between the Insured and Uninsured

Table 1 displays a subset of the wide array of personal and crash characteristics that are available in the CODES data, and compares the uninsured with the privately insured.[11] The basic results are shown in the first three rows: the uninsured stay in the hospital for 6.4 days, compared to 9.2 days for the insured—a thirty percent difference. Similarly, average facility charges are $13,100 versus $20,700. The uninsured have higher mortality rates as well, 4.5% vs. 3.7%.

Median treatment differences are smaller, though still substantial: 4 days in care for the uninsured and 5 days for the insured, while the median facility charges are $6,800 compared with $9,000. As the median and mean comparison shows, the treatment measures are right skewed, though results are not sensitive to the way extreme observations are treated.

Incapacitation at the scene does not mean that patients will have similar observable characteristics. Indeed, if accidents were completely random, then differences in the population, such as age or inclination to wear a seatbelt, would be revealed in the incapacitation sample.

Table 1 shows that the uninsured are more likely to be male (72% vs. 62%). Perhaps surprisingly, they are less likely to substitute self-protection in the form of a restraint (a seat belt or child seat) compared to the insured (19% vs. 30%), consistent with differences in seat belt use found by Clyde et al. (1996). The uninsured are more likely to drive late at night, in older, lighter cars, and in poorer neighborhoods. While these comparisons suggest that the uninsured may suffer more severe injuries, the uninsured are also less likely to have a diagnosis of multiple significant trauma, or to be trapped at the scene—both predictors of mortality. In a regression of mortality on observable characteristics (other than insurance status), the predicted mortality for the uninsured is actually slightly less than the predicted morality for the privately insured (2.5% vs. 2.8%). There are some similarities between the two groups. Both groups come largely from rural areas. In addition, vehicle damage and vehicle types are similar for the two groups.

No Health Insurance vs. No Automobile Insurance

Table 1 suggests that the uninsured tend to be riskier drivers and may have worse health problems in ways that are difficult to control. One way to test the effect of these unobserved differences is to match the uninsured with a similar group of patients. Table 2 shows that patients who have health insurance, but do not have automobile insurance, are similar to the medically uninsured in terms of sex, time and day of the accident, neighborhood characteristics, and areas of injury. In this driver subset, two additional comparisons are available and the groups are again similar: an indicator for driving under the influence of alcohol and an indicator that the driver was at least partially at fault. Those without automobile insurance have also shown a willingness to forgo a form of insurance. The biggest difference in the two groups is the likelihood of driving a motorcycle (24% vs. 42%). Those without auto insurance also tend to come from larger cities and are even less likely to wear a seatbelt. It appears that drivers without auto insurance are riskier than drivers without health insurance, while those with both forms of insurance are the safest. To the extent that unobserved health differences due to risky driving behavior affect the results, comparing these three groups can provide bounds on the estimates of treatment and mortality differences.

4. Empirical Model and Results

The mean comparisons show that the uninsured receive less care and have higher mortality. By conditioning on observable crash and personal characteristics, comparisons are made partially controlling for injury severity. Further, hospital fixed effects are used to control for characteristics that are constant across patients, such as accounting procedures, charity care policies, and trauma resources. Year indicators are also included to control for unobserved characteristics that vary by year, such as technological advancement, but affect both the insured and uninsured. Mortality will be used to test the effect of insurance status on patient outcomes. A linear probability model is used where the dependent variable equals one if the patient died and zero otherwise, which facilitates the use of hospital and year fixed effects.[12]

For person i at hospital h in year t, the estimating equations are:

$$(1) \qquad \ln(Treatment_{iht}) = \gamma_0 + \gamma_1 Uninsured_{iht} + \gamma_2 Personal\,Characteristics_{iht} + \gamma_3 Crash\,Characteristics_{iht} + \gamma_4 Vehicle\,Characteristics_{iht} + \gamma_5 Neighborhood\,Characteristics_{iht} + \theta_h + \delta_t + \varepsilon_{iht} \;,$$

and

$$(2) \qquad Fatal_{iht} = \phi_0 + \phi_1 Uninsured_{iht} + \phi_2 Personal\,Characteristics_{iht} + \phi_3 Crash\,Characteristics_{iht} + \phi_4 Vehicle\,Characteristics_{iht} + \phi_5 Neighborhood\,Characteristics_{iht} + \eta_h + \lambda_t + \upsilon_{iht}$$

with the usual exogeneity assumptions: letting Z represent all right hand side variables,

$$(3) \qquad E(\varepsilon_{iht} \mid Z) = E(\upsilon_{iht} \mid Z) = 0$$

All personal and crash characteristics discussed above are used as controls. Given the wide range of ages in the data set, five age categories are included to allow a non-linear relationship. Individual indicators for the hour of the day and day of the week are also included.[13]

The Uninsured Receive Less Treatment

Table 3 shows that the uninsured receive less treatment, measured by charges and length of stay, controlling for personal, crash, and hospital characteristics. Panel A compares the uninsured and the privately insured, while panel B restricts the privately insured sample to those who do not have automobile insurance. In models that control for crash characteristics but do not include hospital fixed effects, the large treatment differences shown in Table 1 continue to be present in the conditional means: 27 log points fewer charges and 24 log points fewer days in care.

In a model that only includes an indicator for insurance status and fixed effects for hospitals and years, the difference shrinks to 15 log points fewer charges and 20 log points fewer days in care. The hospital fixed effects reduce the treatment difference as the uninsured tend to be treated at hospitals that provide less treatment to everyone. While ambulance drivers are supposed to transport these incapacitated patients to the nearest full-service hospital, it may be that they deliberately take the uninsured to less-equipped, cheaper hospitals. More likely, the uninsured may tend to live (and crash) near less-expensive hospitals. In either case, it is important to consider the effect of hospital and local area characteristics when measuring treatment differences between the insured and uninsured.[14]

The inclusion of controls for crash, vehicle, and personal characteristics do not alter the estimated effect of insurance on treatment. The main results in Columns (3) and (7) include all of the control variables, and total facility charges are approximately 14 log points lower for the uninsured and length of stay is 17 log points lower. An advantage of the relatively large sample of uninsured patients is that the estimates are fairly precisely estimated with standard errors of approximately 0.02.

When the main results are re-transformed from log points to percentages, the uninsured are found to receive 22% fewer facility charges and 20% fewer days of care.[15] Evaluated at the sample mean of the control variables, this represents a difference of $3,300 in facility charges and 1.8 days in care. When the estimation used levels of the dependent variables instead of logs, differences in treatment for total facility charges are $4,100, and 1.6 days for length of stay.

Table 3 also reports models that were estimated with a categorical variable equal to one if the primary payer were a Health Maintenance Organization (HMO), with fee-for-service insurance as the omitted category. HMOs are insurance programs that contract with hospitals and oversee care in an effort to reduce treatment they consider unnecessary or too costly. Accordingly, HMOs are associated with slightly less treatment: three log points fewer days in care and four log points fewer charges. The small difference is not surprising, as fee-for-service plans also contract with hospitals to monitor the care provided. Interestingly, government programs such as Medicare and Medicaid often pay HMOs five percent less than fee-for-service arrangements—a treatment difference similar to the one found here.

Other variables largely have the expected results.[16] Older and rural patients receive more treatment, as do those who were in a head-on collision, suffered multiple significant trauma, or were trapped in their vehicle. Using a seatbelt or child safety seat is associated with less treatment, as expected from previous studies showing the importance of seatbelts in preventing injury. Occupants of vehicles with small engines, motor cycle riders and pedestrians receive more treatment. Women tend to receive slightly less treatment as measured by facility charges, though they stay in care slightly longer.

Panel B shows that the results are similar when drivers with health insurance, but no automobile insurance, are compared to the medically uninsured.[17] This better matched sample reveals larger treatment and mortality differences: 15 log points fewer charges and 19 log points fewer days in care. Given the similarity in observable characteristics, it appears that differences such as income level, vehicle quality, or risk taking behavior are not driving the main results.

Effect on Mortality

Table 4 shows that the uninsured have higher mortality rates as well. The first column shows that the mean mortality difference shown in Tables 1 and 2 continues to be seen in the conditional means. In a model with full controls but with no hospital fixed effects, the uninsured have a 1.2 percentage point higher mortality rate compared to all privately insured, and a 1.6 percentage-point higher mortality rate compared to those with health insurance but no automobile insurance.

When only an indicator for insurance status and hospital and year fixed effects are included in the model, the uninsured are associated with a 1.3 percentage point increase in mortality. This result is stable to the addition of control variables, as shown in column (3) where the uninsured have an estimated 1.5 percentage point higher mortality rate—thirty-nine percent higher than the sample mortality rate of 3.8%. Meanwhile, the control variables have expected effects. For example, wearing a seatbelt reduces the risk of death, while an increased risk of death is associated with suffering multiple significant trauma or being trapped in a vehicle.

The larger mortality difference with the inclusion of hospital fixed effects is partly due to the fact that the uninsured tend to have greater mortality differences in hospitals that serve fewer uninsured patients. This suggests that the uninsured may be treated differently depending on the type of hospital. Nearly all of the hospitals in the data are private and not-for-profit, precluding the usual comparisons of public versus private and non-profit versus for-profit.[18] Nevertheless, the 1992 Wisconsin Hospital Fiscal Survey and the 1992 Annual Survey of Hospitals conducted by the Wisconsin Bureau of Health Information provide detailed information on hospital resources, usage of charity care and bad debt expenses, teaching status, and mission. Mean comparisons suggest that hospitals with greater resources (and potentially greater discretion over a larger number of treatment options) have the largest treatment and mortality differences. Interestingly, nonprofit hospitals that are religiously affiliated have smaller treatment differences and virtually no mortality difference. While these mean differences are found, once personal and crash characteristics are controlled, there are no statistically significant differences across hospital types.[19]

Apart from hospital types, the type of injury will affect the amount of treatment received. When the insurance indicator is interacted the major diagnostic codes, treatment and mortality differences are largely found in the most serious conditions: nervous system and multiple significant trauma. For example, among those with nervous system injuries, the uninsured have 19 log points fewer charges and a 4.2 percentage-point higher mortality rate (compared to a sample mean mortality rate of 6%). These larger differences for the most serious injuries are perhaps not surprising given the greater scope for differences among these complex conditions. Put another way, broken bones appear to be treated in a similar manner regardless of insurance status, at least for inpatient care. The large differences are found in cases where the most complicated procedures are involved, as discussed in more detail below.

Meanwhile, similar results are found in the comparison with patients who do not have automobile insurance, a group that more closely resembles the medically uninsured on observable characteristics. The medically uninsured are found to have a 1.7 percentage point higher mortality rate. HMOs and fee-for-service insurance plans also have similar mortality rates, which is not surprising given the small difference in treatment found between HMOs and fee-for-service insurance plans.

5. Specification and Robustness Tests

Provider sensitivity to insurance status has been offered as an explanation for the lower treatment levels and higher mortality rates among the uninsured. Alternatively, a number of unobserved characteristics can affect the interpretation of the results. That said, unobserved health differences among the uninsured appear to be inconsistent with the finding that the uninsured receive less treatment yet die more often. For example, the mortality difference may be due to more severe injuries suffered by the uninsured, but then more treatment should have been observed for survivors, not less. After all, the charges monotonically increase with police-reported injury severity. Alternatively, less severe injuries would be associated with less treatment and lower mortality—not higher mortality as observed. While less treatment and higher mortality may be expected if the uninsured were more likely to be almost dead on arrival to the hospital, estimates below suggest that these cases have little effect on the estimates. The combination of less treatment and higher mortality suggests that the results are not due to systematic differences in health status.

Further, a number of specification and robustness tests suggest that unobserved heterogeneity in injuries, crash types, and personal characteristics do not drive the treatment and mortality differences. Table 5 reports five such tests. The first provides another look at the automobile insurance-medical insurance comparison. The main results reported treatment and mortality regressed on an indicator that the patient was uninsured. If having no insurance were a proxy for some other cause of the treatment and mortality differences, then an automobile insurance indicator may predict some difference in treatment and mortality. Restricting the sample to patients who have private health insurance, Table 5 shows that automobile insurance is not related to treatment or mortality. This suggests that the ability-to-pay of patients is driving the earlier results—not risk preference or income differences implied by a lack of insurance.[20]

Treatment Differences Within Diagnoses

One difficulty in analyzing the source of the treatment differences, and the margins along which hospitals may substitute care, is that patients would ideally be compared within diagnoses. These diagnoses may be affected by insurance status, however, if health care providers offer less care to the uninsured. In an extreme example, say that the insured and uninsured have identical distributions of illnesses, but the uninsured are more likely to be diagnosed with minor (and less costly) injuries. Then, within a given diagnosis the uninsured would have more serious injuries. Coupled with the fact that patients with more severe injuries generally receive more care, treatment differences would appear smaller, as the effect of insurance on treatment is mitigated by the effect of unobserved injury severity on treatment. At the same time, even larger mortality differences would be expected, as more seriously injured patients have a higher mortality rate.

Table 5 shows that treatment differences are indeed slightly smaller within diagnoses, and mortality differences are somewhat larger. The analysis was restricted to 6,729 observations where there is variation in insurance status within sixty-three principal diagnoses and hospitals. While including the five major diagnostic categories served to control for the broad area of injury, these groups are more specific. For example, three-digit diagnoses include "fracture of the base of the skull" and "fracture of the pelvis". In models with principal diagnosis-times-hospital fixed effects, treatment differences decline to 10 log points fewer charges and 14 log points fewer days in care, while mortality differences increase to 2 percentage points.[21]

Procedure Differences

The above results show that comparisons are qualitatively similar when analyzed within diagnoses. This speaks to the overall robustness of the results and suggests that procedure comparisons within diagnoses may inform the source of the treatment and mortality differences. Consider fractures of the base of the skull—the diagnosis with the largest number of fatalities and a 14% mortality rate. There are 565 such cases and 13.6% are uninsured. The uninsured are less likely to receive an operation on the nervous system, such as a craniotomy: 34% of the insured patients received such brain surgeries, compared to 25% of the uninsured—a difference that is significant at the 10% level. The uninsured with this diagnosis also have higher mortality: 22% versus 13%.

A similar analysis was done for all diagnoses, with a focus on the principal procedure. Some procedures may be routine and inexpensive, while others lead to substantial charges. For example, if a diagnostic procedure usually leads to high charges, this procedure can be thought of as high cost.

To compare the cost of three-digit principal procedures, the Wisconsin Inquiry Tool for Healthcare Information was used to calculate the median charge associated with each procedure. This was done for all 2002 inpatient admissions in Wisconsin. Within a given diagnosis from the crash sample, all principal procedures administered from 1992-1997 were then ranked according to this cost measure. For each patient, an indicator that the principal procedure was “high cost” equals one if the cost measure were greater than the median procedure cost for that patient’s principal diagnosis, and zero otherwise.

Like the brain surgery example, the uninsured tend to receive less costly procedures. 43% of patients were found to receive high-cost procedures, and Table 5 shows that the uninsured are five percentage points less likely to receive one. This 12% difference is similar to the 10 log points fewer charges found in the model with diagnosis-times-hospital fixed effects.

Procedure differences were also found when the estimation did not control for the diagnosis, but instead used the more objective controls employed in the main results. Among the one hundred most frequent three-digit principal procedure codes used in these trauma cases, nineteen procedures were found to differ between the insured and uninsured (at a five-percent level of significance), in models with full controls and hospital fixed effects. Of those nineteen, only “suture or other closure of skin” was greater among the uninsured. The uninsured received fewer spinal fusions, skeletal traction, and operations on the brain, kidney, bladder, chest, large intestine, vessels, and plastic surgery on the face, muscles, and tendons. They also received fewer diagnostic ultrasounds, which suggest that rigorous diagnostic procedures were more common among the insured. At the same time, the uninsured are found to receive fewer amputations, as well. It appears that a lack of health insurance has a significant effect on treatment decisions among a wide range of health problems, including potentially life-saving procedures.[22]

Accident-level fixed effects

Another consideration is that the uninsured may be involved in crashes that are different in ways that are not controlled in the above regressions. For example, the uninsured may be more likely to crash far from a hospital and the longer travel time may explain the mortality result. Table 5 shows the results for 113 accidents where at least one uninsured and one insured patient were deemed incapacitated and visited the same hospital. The treatment and mortality regressions were estimated with accident-times-hospital fixed effects, though alternative specifications yielded similar findings.[23] The results are remarkably consistent with the estimates using the larger sample: 12 log points fewer charges, 17 log points fewer days in care, and a 1.4 percentage-point higher mortality rate. Of course, these estimates are measured with less precision due to the smaller sample sizes, but the similarity in the point estimates supports the robustness of the results.

Passenger Comparisons

One way that the uninsured can affect injury severity is the way they drive. By examining passengers only, it is possible to abstract from the effect of driving quality. While uninsured passengers may be similar to drivers due to positive assortative mating, they likely have less control over the crash. Table 5 shows that the results are similar for the subset of passengers.

The presence of passengers suggests another test based upon the insurance status of co-occupants. If automobile quality or the type of accident were systematically different for the uninsured in ways that are not controlled, then the presence of an uninsured co-passenger should predict treatment and mortality differences. In fact, the presence of an uninsured co-occupant is associated with lower mortality and only slightly less treatment, though these results are less precisely estimated.[24] Meanwhile, controlling for the presence of an uninsured co-occupant does not change the estimated effects of own-insurance status on treatment and mortality. It appears that the types of crashes involving the uninsured are not driving the main results.

Comparison of Injury Severity

Results shown in Table 5 also suggest that the uninsured did not suffer from greater injuries due to the crash. First, insurance status does not predict police-reported injury severity. Using the full sample of survivors, a linear probability model was estimated with the dependent variable equal to one if police report that the patient was incapacitated and zero otherwise. The full set of controls and hospital and year fixed effects are also included, and insurance status does not predict incapacitation. Another test focuses on the use of an ambulance. If the uninsured were more likely to refuse to travel by ambulance and arrive later to the hospital, they may be lost from the sample or have systematically different injuries. Table 5 shows that insurance status does not predict whether the patient uses an ambulance.

Medicaid Recipients vs. the Uninsured

The uninsured are also compared to another group of patients—Medicaid recipients. Medicaid is health insurance publicly provided to those who meet specific criteria such as members of low-income, single-parent families and disabled Supplemental Security Income recipients. If income differences were driving the earlier results, then treatment and outcomes for the uninsured should be similar to Medicaid recipients.

The groups have some large differences, however. The uninsured are older (29 vs. 21) and less likely to be female (28% vs. 49%) due to Medicaid eligibility requirements that favor the inclusion of mothers and children. Accordingly, Table 6 shows that the uninsured are more likely to ride a motorcycle and crash in the middle of the night. The uninsured are also more likely to wear a seatbelt, though this difference goes away when adults are compared. Also, Medicaid recipients are more likely to crash in a large population area (36% vs. 8%).

Given that Medicaid eligibility requires a low income or a disability, this group may have worse underlying health status than the uninsured. This can also be seen from the neighborhoods where Medicaid recipients live. They have lower median incomes ($25,000 vs. $28,000), and have larger nonwhite populations (26% vs. 8%). Despite these differences, Medicaid recipients have similar areas of injury and car sizes (vehicle engines and weights).

Table 7 shows results for treatment and mortality. The effects are magnified, suggesting that income differences between the privately insured and uninsured are not responsible for the earlier results. The uninsured receive substantially less treatment (37 log points fewer charges and 50 log points fewer days in care), and have even higher mortality (by 4.7 percentage points).

While the combination of lower treatment levels and higher mortality for the uninsured provides additional support for the earlier results, the differences are much larger. A likely explanation is that the large differences in the Medicaid population make comparisons difficult. Unlike the privately insured, Medicaid recipients may become incapacitated more easily and require more treatment due to their chronic health problems, despite less severe injuries in the crash. Accordingly, male Medicaid recipients, who are almost always eligible due to disability requirements, have substantially larger treatment differences compared to women and children, many of whom qualify due to income standards.

Another explanation for the larger treatment difference is that Wisconsin Medicaid reimbursement rules may encourage greater treatment levels. In Wisconsin, many of the cases studied here qualify for 'outlier' payments—additional funds from Medicaid based on their high cost. That is, additional charges mean additional reimbursement at the margin.[25] In contrast, most private insurers contract with each hospital and pay on a capitated basis—the hospital is paid a fixed amount for each individual treated as an inpatient. Silverman and Skinner (2001) and Dafny (2002), among others, find that health care providers respond to payment differences across diagnosis categories, while Duggan (2000) finds provider responses to payments as they change over time. Consistent with these earlier findings, the results here suggest that Medicaid's cost-based reimbursement scheme may lead to greater treatment levels for severe injuries.[26]

Propensity Score Approach

The larger treatment differences in the automobile insurance and Medicaid comparisons may be due to more adequately matched samples. This possibility was tested using a propensity score approach (Rosenbaum and Rubin, 1983). The propensity score is a predicted probability that a given patient is uninsured. Within deciles of these scores, the control variables are similar, or balanced, and it is hoped that the unobserved characteristics are also similar. To carry out the analysis, a linear probability model with hospital fixed effects was used to calculate the predicted probability of being uninsured. Across the probability deciles, the uninsured generally receive less treatment and have higher mortality. Four significant differences in charges were found, seven for length of stay, and three for mortality. Segmenting the data into deciles for low probability events like mortality may be asking too much of the data, but the robustness of the results comes through even for these subsets. Perhaps most telling, the two deciles where the patients are most likely to be uninsured show charges differences of -25 and -32 log points, length of stay differences of -20 and -12 log points, and mortality differences both of 1.3 percentage points.[27]

Robustness to Sample Changes and Additional Controls

The results are robust to nearly any subset of the data. For example, the results are similar for samples including: the entire data set, various age subgroups, only drivers, all those who traveled by ambulance even if they were not judged by police to be incapacitated, and all those who did not "leave against medical advice".[28] Table 1 showed that the uninsured are less likely to wear a seatbelt, yet the results are similar when the data are restricted to victims not wearing a seatbelt. Further, if uninsured patients were more likely to be very close to death when entering the hospital, then the combination of less treatment and higher mortality rates may be found. However, the results are unaffected by trimming the data of observations where little care was provided. Excluding large treatment levels, such as patients who stayed in care for more than thirty days, did not affect the results either. Last, specifications that include ZIP code fixed effects have similar estimates (13 log points fewer charges, 16 log points fewer days in care, and 1 percentage point higher mortality).

6. Implications

Previous studies found that the uninsured received approximately forty percent less health care than the insured, though some estimates are as low as twenty-five percent. The estimates here are at the low end of this range, as emergency care is likely to result in greater treatment for the uninsured, and the estimates are less likely to be contaminated by selection bias.

While the treatment difference is less than previously found, it is still substantial. Nevertheless, it represents a relatively low cost of saving a statistical life. The difference in facility charges is estimated to be $3,300 at the sample mean of the control variables. These charges represent an estimate of the total cost of care, as discussed in the data description. With an increased mortality rate of 1.5 percentage points, the implied cost of saving a statistical life, then, is roughly $220,000 (=$3,300/0.015). For the Medicaid-uninsured comparison, the implied cost of saving a statistical life is $209,000.

This is much cheaper than most attempts to lower mortality. Currie and Gruber (1996) estimated that the cost per child's life saved through Medicaid expansions was $1.6 million.

Tengs et al. (1995) discuss five hundred life-saving interventions and find that the median cost per *life-year* saved from fatal injury reductions is $48,000. For other interventions such as toxin control, the estimate increases to $2.8 million. Given the $220,000 cost of saving a statistical life attributed to health insurance, the comparable figure here would be approximately $11,000 per life-year saved.[29]

To place the increased risk of death in context, it is larger than a more commonly considered effect of health provider actions—complications or misadventures during surgery. It is estimated that there is a thirty-percent chance of being in a serious automobile accident in a lifetime.[30] Say the insured and uninsured face that same risk, but the uninsured are more likely to die by 1.5 percentage points. This implies that the uninsured have a 0.45 percentage-point increase in the lifetime risk of dying due to severe automobile accidents. This is over five times the lifetime risk of dying due to complications or misadventures during surgery.

Taking this calculation one step further, it is possible to place a rough value on having insurance. If the value were much larger than the cost of insurance, then these results may be regarded as “too big.” It appears, however, that the cost of catastrophic health insurance is similar in magnitude to the value of the reduction in mortality. Taking the 0.45 percentage point decrease in lifetime risk, then the annual decrease in the risk of death for an insured adult is on the order of 0.01 percentage points. Given a value of life estimate of three million dollars, the willingness to pay for a 0.01 percentage point decrease in the annual risk of death would be approximately $300(=$3,000,000*0.0001) per year. In a casual survey of catastrophic insurance rates in Wisconsin, a policy with a $1500 deductible was found to be approximately $300 per year for a twenty-three year old man. It appears, then, that the magnitudes of the benefits and costs of catastrophic insurance are roughly similar and that the mortality differences are not unreasonably large.

Flat-of-the-curve Medicine & Welfare Implications

As with previous estimates, the insured are found to receive more treatment. However, the welfare implications are less straightforward. For example, the uninsured may not value additional treatment as much as the insured, as suggested by the choice to purchase insurance.

One case where inefficiencies would be more easily tested is moral hazard. Consider a health production function that maps treatment into health benefits. It has been argued that at the advanced state of technology in the U.S., diminishing returns have resulted in physicians practicing 'flat-of-the-curve' medicine. That is, the insured may receive more care, but it may have little effect on health outcomes. If this were the case, the marginal benefit of treatment would be close to zero, which is less than the positive marginal cost, and welfare implications would stem from distorted insurance prices.

Empirical tests of treatment effectiveness are usually complicated by the fact that more severely ill patients receive more health care. An alternative characterization of the results is to consider insurance status as an instrumental variable for treatment. If insurance status were related to treatment levels because providers are sensitive to the patient's ability-to-pay, and not due to differences in unobserved injury severity, then insurance status could used as an instrumental variable for treatment. This would break the spurious positive relationship between treatment and mortality. The first stage is represented in Table 3, where treatment is regressed on insurance status to calculate the predicted facility charges. The second stage, which predicts the probability of death, reveals a coefficient on the instrumented charges of –0.110 with a standard error of 0.047. This implies that a ten percent increase in facility charges is associated with a reduction in the mortality rate of roughly 1.1 percentage points.[31] Again, this is a large difference as suggested by the low cost per statistical life saved calculated above. The mortality differences found here suggest that we are not on the flat of the curve when it comes to trauma care, so it is not clear that the insured are receiving too much care.

7. Conclusion

Using automobile accidents as unexpected health shocks, when contact with medical professionals is virtually automatic, this paper avoids a selection problem inherent in most previous studies. The results suggest that there are real consequences to being uninsured. Controlling for personal, crash, vehicle, neighborhood, and hospital characteristics, the uninsured are estimated to receive 20% less treatment than the privately insured following serious accidents. In addition, there appear to be large effects on mortality. The uninsured are found to have a 1.5 percentage point higher mortality rate compared with a mean mortality rate of 3.8%. These estimates imply that physicians are not practicing 'flat-of-the-curve' medicine, at least in these trauma cases.

Provider sensitivity toward insurance status appears to account for the difference in care, as opposed to unobserved characteristics of the uninsured. For example, similar groups, such as drivers who have health insurance but do not have automobile insurance, receive more treatment and die less. In addition, the uninsured receive fewer major operations—decisions that are likely the domain of physicians. Finally, the combination of less treatment and higher mortality is inconsistent with systematic differences in health status between the insured and uninsured. It appears, then, that having health insurance significantly affects treatment decisions and ultimately patient outcomes.

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[1] Adverse selection and moral hazard suggest that the insured will receive more care as well. In addition, agents will differ with respect to tastes and income. Perhaps the most interesting difference for this current study is that individuals with a relatively high degree of risk aversion may be more likely to purchase insurance and drive safely (de Meza and Webb, 2001; Jullien, Salanie, and Salanie, 1999). While this is not a general result, it suggests the potential for a negative correlation between insurance coverage and health risk. The potential for heterogeneity in risk preference is considered below.

[2] See for example, Currie and Thomas (1995), Haas and Goldman (1994), Long, Marquis, and Rodgers (1998), Marquis and Long (1994), Spillman (1992), and Tilford et al. (1999). Brown

(1998) reviews the health literature, while Levy and Meltzer (2001) review the economics literature. In a related literature, moral hazard problems in Workers Compensation have been studied, with reported injuries seemingly affected by changes in insurance generosity (Dionne and St-Michel (1991) and Fortin and Lanoie (1992)).

[3] Haas and Goldman (1994) show that the emergency case mix differs substantially between the insured and uninsured, though they do not control for injury type beyond a control for penetrating injury, such as gun shot wounds.

[4] Wisconsin is one of the original CODES states and the only state that regularly supplies a public-use data set. All 23 CODES states were contacted. Most of the other states are still in the process of linking the data or did not have key variables of interest.

[5] The scores of K are the raw data for the often-used Fatality Analysis Reporting System (FARS) distributed by the National Highway Traffic Safety Administration. It is generally regarded as 'thirty-day mortality' meaning that deaths up to thirty days from the accident are recorded in the police data, though deaths after thirty days are also recorded. For a small number of cases the patient died in the hospital and the KABCO score does not equal K. These have been coded as fatal injuries in the analysis, though results are not sensitive to this definition. As noted above, those who die at the scene do not enter the inpatient data.

[6] The cost audits are consistent with private insurers typically contracting with hospitals to pay seventy-five to eighty percent of charges. These audits also reveal that accounting procedures do vary by hospital—one reason for exploiting within-hospital variation. Data for Wisconsin show that total operating costs are seventy-one percent of total charges (US DHHS, 2003). Meanwhile, facility charges exclude costs such as physician fees. Aggregate data suggest that physician fees are on the order of 23% of total inpatient costs (US DHHS, 2000).

[7] Much of hospital bad debt is due to catastrophic events to uninsured patients, suggesting they often do not get paid (Saywell, et al. 1989). Clyde et al. (1996) find that 77% of uninsured crash victims admitted to Massachusetts General Hospital over a two month period generated bad debt, compared to 23% for the insured. In addition, Wisconsin is not a no-fault insurance state. That is, reimbursement from an insurance company would require proving that another driver was at fault. Also, at the time of these crashes, Wisconsin was one of the few states that did not require automobile policies to include liability insurance.

[8] According to the National Safety Council's 1996 *Manual on Classification of Motor Vehicle Traffic Accidents*, an incapacitating injury is "any injury, other than a fatal injury, which prevents the injured person from walking, driving or normally continuing the activities the person was capable of performing before the injury occurred. Inclusions: severe lacerations, broken or distorted limbs, skull or chest injuries, abdominal injuries, unconsciousness at or when taken from the accident scene, and unable to leave the accident scene without assistance, and others. Exclusion: momentary unconsciousness". It appears that almost all of those with fatal injuries were incapacitated at the scene as evidenced by their nearly universal rate of ambulance transfer.

[9] Of the incapacitated crash victims, 5.7% were transferred. In a regression predicting hospital transfer with full controls, an indicator of not having health insurance has a coefficient of –0.004 with a standard error of 0.005.

[10] The restrictions dropped 2,113 observations due to age; 804 due to transfer; 717 due to missing hour of day or major diagnostic code values, and 107 when all of the patients in a particular hospital were insured. There were also 2,065 observations where the patient has Medicaid or other government insurance. Medicaid recipients are examined below.

[11] The working paper version of this paper includes mean comparisons for all observed characteristics.

[12] The results are similar when probit models are estimated.

[13] The Vehicle Identification Number (VIN) is recorded for 83% of car and truck crash victims (84% for privately insured and 79% for the uninsured). For observations with missing vehicle information, and for motorcyclists, bicyclists and pedestrians, the data have been filled with sample mean values and an indicator for missing VIN information is included. A second indicator is included for the subset of observations where all of the vehicle information is available except for vehicle weight. This is largely due to older VINs that do not contain such information, and vehicle age is controlled in the analysis with model-year indicators. Similarly, for the two percent of the observations that came from ZIP codes where Census data have been suppressed due to small population sizes, an indicator for these observations has been included in the analysis. Results are similar when alternative specifications are used, as discussed below.

[14] The smaller estimates may also be explained by the increased influence of measurement error in models with fixed-effects. However, this explanation is not consistent with the mortality results shown below.

[15] The natural logarithm of each treatment measure is used, as is standard in the health literature where the measures, such as length of stay in the hospital, are right skewed. When interpreting the estimates in terms of percentages or dollars, as opposed to log points or log dollars, the results are re-transformed, and it is necessary to consider heteroskedasticity (Manning, 1998). In forming the nonparametric "smearing factor", the average exponentiated residuals in the charges regression are 1.44 for the uninsured and 1.61 for the insured. For length of stay, they are 1.36

and 1.43. The expected charges and length of stay for the insured are calculated to be $15,174 and 9.0 days, evaluated at the sample mean of the control variables.

[16] These estimates are available in the working paper version.

[17] In models comparing all drivers, the results are similar, and the inclusion of indicators for having automobile insurance, driving under the influence, and being at fault do not change the estimates.

[18] The only public hospital closed in 1995 (other than the University of Wisconsin's teaching hospital), and there are no for-profit hospitals in these data.

[19] In particular, the main regressions were re-estimated with the addition of interactions between the hospital fixed effects and the uninsured indicator. The coefficients represent the average treatment or mortality difference for a given hospital, controlling for crash characteristics. These 112 fixed-effect interactions were then regressed on hospital characteristics, including categories for debt, charity care, return on assets, number of intensive care unit beds, income from public resources, religious affiliation, and teaching status. No significant differences were found, either weighted by the number of patients used to construct the treatment/mortality differences or unweighted.

[20] Analysis was also conducted considering only those who do not have automobile insurance—a smaller sample of 1192 patients of which 30% are medically uninsured. The two groups are similar in terms of seat belt use and areas of injury, while the medically uninsured still tend to come from smaller cities and are less likely to ride a motorcycle. Similar results are found with the medically uninsured receiving 21 log points fewer charges with a standard error of 0.064 and 24 log points fewer days in care with a standard error of 0.057. They also have a mortality rate

that is 0.8 percentage points higher (standard error 0.011)—again a large difference given the sample average of 2.0 percent, though it is less precisely estimated.

[21] The results are similar when 93 diagnostic related groups are considered: 10 log points fewer charges, 15 log points fewer days in care, and a 2.5 percentage-point higher mortality rate. These diagnosis groups are used by third-party payers to compensate hospitals for patients who receive particular combinations of diagnoses and procedures, such as "peripheral and cranial nerve and other nerve system procedures".

[22] The mean number of observations for the 100 comparisons is 83, the median is 19, the minimum is 6 and the maximum is 1622. When hospital fixed effects are removed from the models, 22 of the top 100 procedures show differences (again at the five-percent level), where two are greater for the uninsured: sutures and "alcohol and drug rehabilitation and detoxification." This again points to the potential differences between the two groups, though controlling for driving under the influence of alcohol does not affect the main results.

[23] Another 68 accidents occurred with incapacitated insured and uninsured occupants who were delivered to different hospitals. Incorporating these accidents in models with accident fixed effects, but no hospital fixed effects, the coefficients (standard errors) on charges, length of stay, and mortality are -0.14 (0.10) ,-.20 (.09) , and .010 (.02) respectively. Including hospital fixed effects yields estimates of -0.08 (0.12), -0.16 (0.10), and 0.015 (0.03), respectively.

[24] These models are for cars and trucks only, resulting in 7,958 observations. The coefficients (standard errors) on having another occupant in the car are 0.05 (0.03), 0.06 (0.03), and 0.001 (0.007) for log charges, log length of stay, and mortality, respectively. The coefficients on the interaction of having another occupant in the car and having an uninsured co-occupant are -0.10

(0.07), -0.06 (0.06), and -0.013 (0.013), respectively, with the effect of having an uninsured co-occupant calculated by taking the sum of the two coefficients in each model Meanwhile, the coefficients on not having insurance in models with these new controls remain -0.14 (0.03), -0.17 (0.03), and 0.014 (0.007), respectively.

[25] When costs exceed reimbursement by $31,000 for large hospitals and $5,100 for small hospitals, Medicaid reimbursement is roughly fifty percent of the hospital charges above the threshold.

[26] Another explanation would be that the most severely-injured uninsured patients were deemed disabled and therefore eligible for Medicaid. In this case, the remaining uninsured patients would necessarily receive lower treatment levels. However, the expected payer is defined as the person or organization to which the bill was originally submitted. According to Wisconsin hospital administrators, determining Medicaid eligibility usually takes over five months—long after most patients are discharged. As discussed below, the comparisons are robust to restricting the sample to stays that were less than one month.

[27] Charge differences ranged from -0.02 to -.41, with seven of the ten deciles showing differences of 14 log points or more. Length of stay differences ranged from -0.05 to -.32, with eight of the ten deciles showing differences of 9 log points or more. Mortality differences ranged from -0.04 to 0.06, with six of the ten deciles showing the uninsured having at least a one percentage-point higher mortality rate. The four percentage-point lower mortality for the uninsured was estimated in the decile where the patients were the least likely to be uninsured. This result is not robust across specifications.

[28] The working paper version of this paper includes the estimates.

[29] Assuming an equal cost per life-year saved and a discount rate of 5%, the discounted present value of spending $11,000 each year in perpetuity would be approximately $220,000—the cost of saving a statistical life calculated above.

[30] The National Safety Council calculates the lifetime risk of death in an automobile accident to be roughly 1.25%. This is roughly consistent with the estimated thirty-percent chance of a severe accident and a 4% chance of death once in a severe accident. The lifetime risk of death due to complications or misadventures during surgery is calculated to be 0.08%.

[31] This result can be derived from the above tables where the coefficient on uninsured in the mortality regression is divided by the coefficient in the facility charges regression to form an IV estimate of the effect of charges on mortality. The IV estimate on log length of stay on mortality is -0.088 with a standard error of 0.032.

Table 1: Insured vs. Uninsured: Selected Variables

Variable		Privately Insured Mean	Privately Insured Std Dev	Uninsured Mean	Uninsured Std Dev	t
Treatment	Length of Stay	9.17	13.93	6.44	8.30	7.56
	Facility Charges ('000s)	20.68	37.34	13.10	19.75	7.88
Outcome	Mortality	0.037	0.19	0.045	0.21	1.60
Personal Characteristics	Female	0.38	0.49	0.28	0.45	7.24
	Restraint seat belt/child seat	0.30	0.46	0.19	0.39	9.59
Vehicle Types	Car	0.61	0.49	0.60	0.49	0.53
	Motorcycle	0.14	0.35	0.15	0.36	1.20
	Vehicle Weight: <2420 pounds	0.25	0.43	0.30	0.46	3.06
	Vehicle Age: <=4 years-old	0.28	0.45	0.19	0.39	5.71
Crash Characteristics	Severe vehicle damage	0.49	0.50	0.48	0.50	0.98
	Trapped	0.17	0.38	0.15	0.36	2.34
	Head-on collision	0.13	0.33	0.12	0.32	1.12
	Angle collision	0.29	0.45	0.22	0.42	5.76
Road Types	Urban street	0.20	0.40	0.22	0.42	2.12
	Rural street	0.36	0.48	0.39	0.49	1.75
	Rural highway	0.30	0.46	0.27	0.44	2.36
Day and Hour	Weekend	0.53	0.50	0.56	0.50	2.53
	Between 11pm and 7am	0.24	0.43	0.32	0.47	6.56
Major Diagnostic Categories	Nervous system	0.20	0.40	0.22	0.41	0.98
	Musculoskeletal & tissue	0.35	0.48	0.35	0.48	0.03
	Multiple significant trauma	0.20	0.40	0.16	0.37	3.16
Neighborhood Characteristics	White	0.94	0.13	0.92	0.17	3.52
	Median household income	30726	8188	27955	7752	8.76
	Observations	9261		1581		

Missing observations result in 6,668 observations for Vehicle age; 6,113 for vehicle weight.
t-tests for neighborhood comparisons use standard errors clustered by ZIP code and 10,585 observations.

Table 2: No Auto Insurance vs. No Health Insurance: Selected Variables

Variable		Privately Insured w/ No Auto Ins. Mean	Privately Insured w/ No Auto Ins. Std Dev	No Health Insurance Mean	No Health Insurance Std Dev	t
Treatment	Length of Stay	9.06	10.91	6.66	7.90	4.77
	Facility Charges ('000s)	21.03	32.85	14.60	22.65	4.29
Outcome	Mortality	0.019	0.14	0.036	0.19	2.05
Personal Characteristics	Female	0.24	0.43	0.27	0.44	1.28
	Restraint seat belt/child seat	0.14	0.35	0.23	0.42	4.62
Vehicle Types	Car	0.49	0.50	0.63	0.48	5.22
	Motorcycle	0.42	0.49	0.24	0.43	7.29
Road Types	Urban street	0.23	0.42	0.17	0.38	2.80
	Rural highway	0.25	0.43	0.29	0.45	1.73
Day and Hour	Weekend	0.60	0.49	0.57	0.50	1.09
	Between 11pm and 7am	0.31	0.46	0.31	0.46	0.13
Major Diagnostic Categories	Nervous system	0.19	0.39	0.18	0.39	0.37
	Musculoskeletal & tissue	0.39	0.49	0.38	0.49	0.13
	Multiple significant trauma	0.17	0.38	0.16	0.37	0.66
Neighborhood Characteristics	White	0.93	0.14	0.93	0.14	0.03
	Median household income	29432	7162	28890	7657	1.27
Driver Indicators	At fault	0.71	0.45	0.77	0.42	2.36
	DUI alcohol	0.38	0.49	0.42	0.49	1.24
	Observations	807		671		

Data are for drivers only.
t-tests for neighborhood comparisons use standard errors clustered by ZIP code and 1,447 observations.

Table 3: The Uninsured Receive Less Treatment than the Privately Insured

A. Privately Insured vs. Uninsured

	Ln(Facility Charges)				Ln(Length of Stay)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
No Health Insurance	-0.273	-0.149	-0.137	-0.145	-0.238	-0.203	-0.170	-0.182
	(0.026)	(0.026)	(0.025)	(0.026)	(0.022)	(0.023)	(0.022)	(0.024)
HMO				-0.044				-0.028
				(0.026)				(0.022)
Full Controls	Yes	No	Yes	Yes	Yes	No	Yes	Yes
Hospital Fixed Effects	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Observations	10840	10840	10840	9861	10842	10842	10842	9863
R-squared	0.24	0.25	0.39	0.39	0.15	0.12	0.23	0.23

B. Privately Insured w/ No Auto Insurance vs. No Health Insurance

	Ln(Facility Charges)				Ln(Length of Stay)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
No Health Insurance	-0.262	-0.178	-0.148	-0.155	-0.229	-0.218	-0.190	-0.191
	(0.053)	(0.055)	(0.053)	(0.061)	(0.045)	(0.046)	(0.046)	(0.052)
HMO				-0.051				-0.032
				(0.088)				(0.078)
Full Controls	Yes	No	Yes	Yes	Yes	No	Yes	Yes
Hospital Fixed Effects	No	Yes	Yes	Yes	No	Yes	Yes	Yes
Observations	1478	1478	1478	1380	1478	1478	1478	1380
R-squared	0.29	0.26	0.43	0.43	0.19	0.14	0.29	0.29

Full controls include all personal, vehicle, crash, road, and neighborhood characteristics, as well as hour of day, day of the week, and year indicators.
Robust standard errors in parentheses.

Table 4: The Uninsured Have Higher Mortality

A. Privately Insured vs. Uninsured

	Mortality			
	(1)	(2)	(3)	(4)
No Health Insurance	0.012	0.013	0.015	0.016
	(0.006)	(0.006)	(0.006)	(0.006)
HMO				-0.002
				(0.005)
Full Controls	Yes	No	Yes	Yes
Hospital Fixed Effects	No	Yes	Yes	Yes
Observations	10842	10842	10842	9863
R-squared	0.06	0.03	0.07	0.07

B. Privately Insured w/ No Auto Insurance vs. No Health Insurance

	Mortality			
	(1)	(2)	(3)	(4)
No Health Insurance	0.016	0.022	0.017	0.020
	(0.009)	(0.009)	(0.009)	(0.010)
HMO				0.001
				(0.012)
Full Controls	Yes	No	Yes	Yes
Hospital Fixed Effects	No	Yes	Yes	Yes
Observations	1478	1478	1478	1380
R-squared	0.12	0.05	0.15	0.16

Full controls include all personal, vehicle, crash, road, and neighborhood characteristics, as well as hour of day, day of the week, and year indicators. Robust standard errors in parentheses.

Table 5: Additional Tests

Specification	Dependent Variable	Uninsured Coeff.	Std. Error	Mean of Dep. Var.	Observations
Uninsured=No Auto Insurance	Ln(charges)	-0.005	(0.037)	2.298	5257
Drivers with private health insurance	Ln(length of stay)	-0.007	(0.031)	1.751	
	Mortality	-0.006	(0.006)	0.027	
Diagnosis*Hospital Fixed Effects	Ln(charges)	-0.096	(0.029)	2.391	6729
	Ln(length of stay)	-0.138	(0.026)	1.791	
	Mortality	0.020	(0.007)	0.046	
	High Cost Procedure	-0.050	(0.016)	0.430	6648
Accident*Hospital Fixed Effects	Ln(charges)	-0.119	(0.133)	2.068	249
	Ln(length of stay)	-0.171	(0.115)	1.587	
	Mortality	0.014	(0.033)	0.028	
Car Passengers	Ln(charges)	-0.193	(0.054)	2.193	2360
	Ln(length of stay)	-0.240	(0.048)	1.683	
	Mortality	0.012	(0.012)	0.038	
Injury Severity					
All Survivors	Incapacitated	-0.004	(0.010)	0.605	17311
All	Go in Ambulance	-0.002	(0.007)	0.880	17743

All models include full controls. Robust standard errors are reported.

Table 6: Uninsured vs. Medicaid: Key Differences

Variable		Medicaid Mean	Medicaid Std Dev	Uninsured Mean	Uninsured Std Dev	t
Treatment	Length of Stay	13.90	24.68	6.55	8.42	10.79
	Facility Charges ('000s)	29.91	64.15	13.41	20.02	9.42
Outcome	Mortality	0.033	0.18	0.046	0.21	1.65
Personal Characteristics	Female	0.49	0.50	0.28	0.45	11.12
	Restraint seat belt/child seat	0.12	0.33	0.18	0.39	4.09
	Driver	0.29	0.45	0.49	0.50	10.51
Vehicle Types	Truck	0.05	0.22	0.13	0.34	6.64
	Motorcycle	0.04	0.20	0.15	0.36	9.12
	Vehicle Age: <=4 years-old	0.09	0.29	0.18	0.38	4.15
Crash Characteristics	Severe vehicle damage	0.33	0.47	0.48	0.50	7.77
	Head-on collision	0.07	0.25	0.12	0.32	4.42
	Between 11pm and 7am	0.20	0.40	0.32	0.47	6.44
	Large town >250,000	0.36	0.48	0.08	0.27	18.44
Neighborhood Characteristics	White	0.74	0.32	0.92	0.17	3.24
	Median household income	24676	7669	28014	7789	3.73
	Observations	1090		1525		

Missing observations result in 1306 observations for Vehicle age.
t-tests for ZIP-code comparisons use standard errors clustered by ZIP and 1,447 observations.

Table 7: Uninsured vs. Medicaid: Treatment & Mortality Differences

	Ln(Facility Charges)			Ln(Length of Stay)			Mortality		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
No Health Insurance	-0.255	-0.370	-0.374	-0.428	-0.497	-0.498	0.034	0.047	0.044
	(0.048)	(0.050)	(0.052)	(0.042)	(0.044)	(0.046)	(0.009)	(0.010)	(0.010)
Medicaid HMO			-0.033			-0.001			-0.020
			(0.090)			(0.082)			(0.017)
Full Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Observations	2615	2615	2615	2615	2615	2615	2615	2615	2615
R-squared	0.27	0.42	0.42	0.17	0.29	0.29	0.05	0.13	0.13

Models include hospital fixed effects.
Full controls include all personal, vehicle, crash, road, and neighborhood characteristics, as well as hour of day, day of the week, and year indicators.
Robust standard errors in parentheses.